Changkat Changi Secondary School

UNIT 4

Mass, Weight & Density

Name: _____

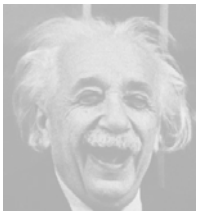
Class: _____

Date: _____

CONTENT PAGE

"Gravitation is not responsible for people falling in love."

---Albert Einstein



NOTES 4.1

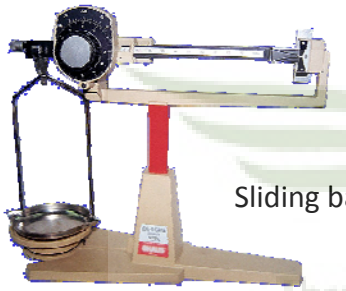
LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- understand that mass is a measure of the amount of substance in a body
- understand that the mass of a body resists a change in the state of rest or motion of the body (inertia)
- understand that weight is the force of the gravitational pull acting on a body(object)

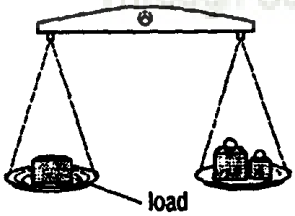
What is Mass?

- ❒ Mass of an object is the **measure** of the **amount** of_____(substance) in it.
- ❒ It has a SI unit of kilogram (_____).
- ❒ Though smaller masses are measured in grams (g) and larger masses are measured in tonnes (1 tonne = 1000 kg).
- ❒ Mass of a body remains the **same**, whether it is on Earth or anywhere in the Universe. It can be measured using sliding **beam balance**, or **electronic balance**.



Sliding balance

Electronic balance



Beam balance

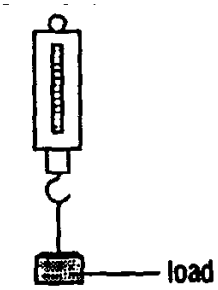
Relationship between Mass and Inertia

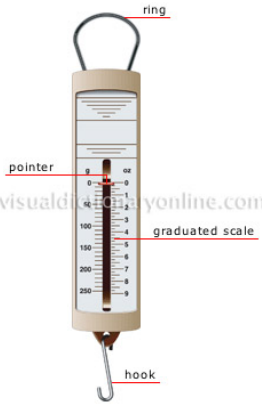
- ❒ All objects with mass possess a property known as **inertia**.
- ❒ The inertia of a body is a measure of the _____ of the object to change either its state of **rest** or, if it is moving, its **motion** in a straight line.
- ❒ The greater the mass, the greater is the inertia. i.e. The more massive an object, the harder it is to get it moving or to get it to stop moving.
- ❒ Can you think of objects which are hard to get moving or stop moving?

Try it! What happens to a drinking mug when the piece of tablecloth underneath it is pulled off quickly?

What is Weight?

- ❒ Weight of an object is the force of Earth's gravitational pull on the object.
- ❒ S.I. unit of weight is **newton** (N).
- ❒ Weight varies from places with different gravitational pull. E.g. A person weighs less on moon than on earth.
- ❒ Weight of objects can be measured **spring balance or newton meter** shown below.





Spring balance or newton meter

- ❒ All objects (bodies) fall towards the centre of the Earth and hence the direction of weight is always towards the center of earth, regardless of where you are. This is due to the gravitational force acting towards the center of earth. Can you draw the direction of weight on the people figures below?

Differences between Mass and Weight

Mass	Weight
Amount of matter in the body	Force of gravity acting on a body
Constant at any location	Varies according to the acceleration due to gravity at the location
Scalar quantity [magnitude only]	Vector quantity [both magnitude and direction]
SI units: kilograms (kg)	SI units: newtons (N)
Measured using a beam balance	Measured using a spring balance
Can never be zero	Can be zero (weightlessness)

NOTES 4.2

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

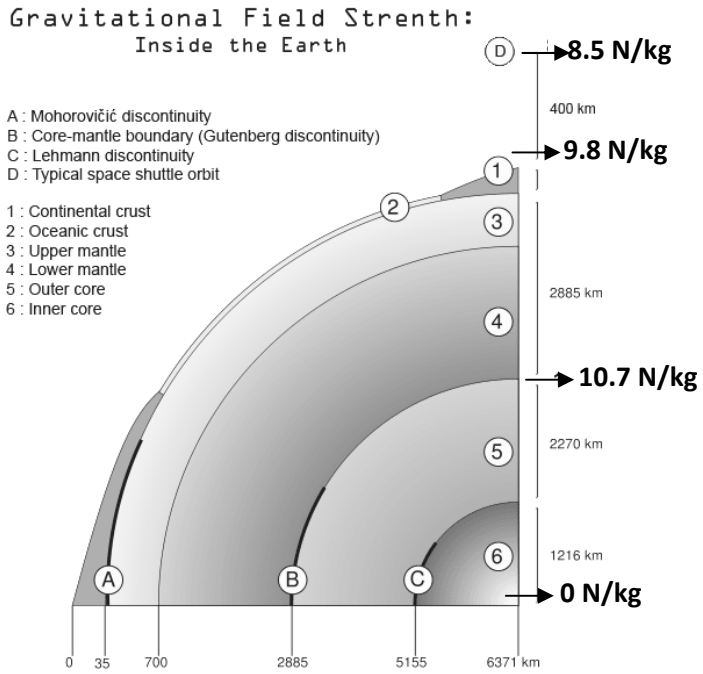
- state that a gravitational field is a region in which a mass experiences a force due to gravitational attraction
- define gravitational field strength, *g* as *gravitational field strength* know, recall and apply the relationship between weight and mass is given by the equation: *weight* = *mass* x *gravitational field strength*.
- distinguish between *mass* and *weight*

What is a gravitational field?

- ❒ **A gravitational field** is a **region** in which an object with a mass experiences a force due to the gravitational attraction.
- ❒ Due to the earth's large _____, a gravitational field is present near the earth surface. Any object in the earth's gravitational field will experience a force pulling it **towards** the _____ of the earth.
- ❒ The force is **strongest** on the surface of the Earth and gets **weaker** as the object moves further away from the surface.

Gravitational Field Strength

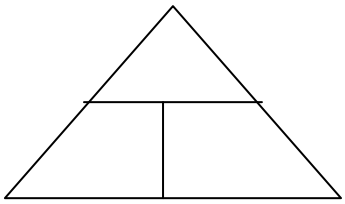
- ❒ To differentiate the gravitational force acting on an object, the term gravitational field strength is used.
- ❒ Gravitational field strength ( ) at any point in a field is defined as the gravitational force per unit mass.
- ❒ It has a unit of _____ or _____(known as acceleration of free fall).
- ❒ At the Earth's surface (or near it), the gravitational field strength is taken to be a constant value of _____ N kg^{-1}.



Calculating weight

- If mass = 1 kg, then gravitational force on it = 10 N.
  If mass = 5 kg, then gravitational force on it = 50 N.
- Since gravitational field strength = (weight) / (mass), weight can be expressed as a **product** of **mass(m)and gravitational field strength acting on the object(g).**

- In equation, we write :



For example, determine the weight of a 100kg man on the moon and earth where g of earth is 10 N/kg and that of moon is 1.6N/kg.

NOTES 4.3

LESSON OBJECTIVES

At the end of the lesson, you will be able to:

- know how to apply the relationship *density* = *mass* / *volume* to new situations or to solve related problems.

What is density?

DENSITY is a physical property of matter, as each element and compound has a unique density associated with it. Density defined in a qualitative manner as the measure of the relative "heaviness" of objects with a constant volume.

For example: A rock is obviously more dense than a crumpled piece of paper of the same size. A styrofoam cup is less dense than a ceramic cup.

Density may also refer to how closely "packed" or "crowded" the material appears to be - again refer to the styrofoam vs. ceramic cup.

Calculating density

- Density of a substance is defined as the _____ of a substance per unit _____.
- In equation, we write :

- SI unit of density is kg/m^3.

Example

A container weighs 5 N when empty and 35 N when completely full of petrol.
The capacity of the container is 4×10^{-3} m (4 litres).
Calculate
(a) the mass of petrol in the container when it is full (assume that the force of gravity acting on a mass of 1 kg is 10 N),
(b) the density of the petrol.

❒ Table below shows a list of substances and their density.

Substance	Density (kg m^{-3})
Gases	
dry air	1.225
oxygen	1.43
Liquids	
turpentine	870
oil	920
pure water	1000
sea water	1025
mercury	13 600
Solids	
polystyrene	16
cork	240
pine wood	500
ice (at –4 °C)	917
crown glass	2500
iron	7874
gold	19 300

Try it! Float or sink?

Place a block of plasticine into a cup of water.
What happens?
Now place a cork material of about same mass of plasticine into a cup of water.
What happens?
What can you conclude?

Example

25 cm^3 each of mercury, oil and water are poured into the tall jar shown below in Fig. 2. If the liquids do not mix, show clearly with the appropriate markings and labelling, the appearance of the jar when its contents have had time to settle. Use the table above to help you draw what you would observe.